

BHEL Corporate R&D, Hyderabad

CoE for Permanent Magnet Machines

SPECIFICATION FOR MOTOR-FAN UNIT (REV00)

KW : 350 KW RPM

The design & manufacturing of the FV unit will be in the scope of the vendor. Selection of blower units is to be done by the supplier so as to fully meet requirements as listed below.

1. DESIGN DATA

1.1 Heat Load (KW) : 28

1.2 Air flow (Cubic Metre/Sec): 1.0 (Unidirectional, centrifugal blower)

1.3 Inlet Temperature for
Fan motor unit (Deg. C) : 55

1.4 Pressure Drop (mm)
- Across the motor : 75

2.0 vibration level : Vibration Levels. Vibration levels in 1/3 Octave band frequency range from 25 Hz to 8 KHz with a reference to $1 \times 10^{-5} \text{ m/sec}^2$ when measured above shock absorbers should not exceed the straight line joining the values as specified: -
(a) At 25 Hz - 70 dB
(b) At 8 KHz - 95 dB

3.0 Ambient : 55 Deg. C

4.0 Noise level : Limited to 75 dBA at 1 meter with blower running at full Speed.

5.0 FV unit Drg. No : 34023540118

6.0 SPECIFICATION OF BLOWER MOTOR:

6.1 KW Rating : To be selected by Supplier

6.2 voltage Rating : 380 +/- 10 % Volts.

6.3 No of Phases / poles : 3 / 4 Pole preferred

6.4 Frequency : 50 +/- 5 % Hz.

6.5 Type of motor : Inverter duty, energy efficient

6.6 Enclosure : TEFC (IC411)

6.7 Protection : IP 55

6.8 Duty : S1.

6.9 Make : DMDE approved vendors.

- 6.10 Reference standard : IS-325/ IEC-60034 / IS12615
- 6.11 Class of Insulation : Class F(with VPI) with temperature rise limited to Class B
- 7.0 Terminals : Leads from blower should be properly terminated in a terminal Box on the casing along with proper glands for Supply cable.
- 8.0 Name Plates : a) Metallic Name plate should be provided at a clearly visible place on casing giving following information.
1) Name of the Supplier
2) Work Order No
3) Drg. No.
b) Metallic arrow marking plate should be provided on the side of the casing at a readily visible place separately for the following:
i) Direction of Air flow
ii) Direction of rotation of blower motor
- 9.0 Impeller dia : As compact as possible
- 10.0 Earth Protection : External earthing terminals to be provided.
- 11.0 Thermal protection : Using PT-100, 3-Wire, Simplex RTDs.
- 12.0 Testing : As per IS-325.
- 13.0 Special technical requirement :
- i) Shock resistance: If the developed equipment weighs less than 200 KG, the same will be tested for sock withstand ability in K-200 sock testing machine available at DMDE (without shock mounts). If developed machine, weighs more than 200kgs, either testing has to be carried out using suitable mechanism or sock analysis has to be carried out (in line with the annexure A of enquiry specification). The responsibility of either test or analysis shall be in the scope of vendor.
- ii) Vibration Resistance: The equipment should be able to withstand vibration levels as specified below, with equipment rigidly installed (without shock mount) :-
(a) 1 Hz to 5 Hz - Acceleration of 0.1 g (9.81 m/sq sec)
(b) 5 Hz to 50 Hz - Acceleration of 2.0 g
- iii) Air Borne Noise. Average level of sound pressure measured in the test bed in accordance with ISO 3744 on conformed surface at a measuring distance of one meter, in dB (A) with respect to reference threshold level of 2×10^{-5} N/m² should not exceed 75 dBA.
- iv) Temperature and Humidity Specifications.
The equipment / system component should be able to function satisfactorily under the following environmental conditions:
(a) Operating Temperature - Up to 55° C.
(b) Storage Temperature - Up to 60° C.

Relative Humidity

	Temperature	Relative Humidity	Period
Temperatures at Machinery Spaces	0-55°C	95 ± 3%	Continuous

v) EMI/ EMC requirement:

The EMI/EMC requirement shall be as per annexure B

vi) Environmental Tests. The following type tests are to be conducted on the equipment in accordance with JSS 55555. In case test facility is not available, then the testing may be carried out by means of analysis from a competent organization which will be approved by the customer.

- (a) Vibration Resistance.
- (b) High Temperature Test
- (c) Damp Heat Test
- (d) Low Temperature Test
- (e) Mould Growth Test
- (f) Salt Corrosion Test

vii) Availability reliability & maintainability (AR & M)

1) Equipment availability

- a) The probability that the equipment will be available (i.e., not undergoing corrective maintenance) at any instant during the operational period is to be not less than 99.85%.
- b) The downtime due to preventive maintenance activities during the operational period is not to exceed 02 hours (On line maintenance only during 2000 hours operational time).
- c) Sufficient onboard spares are to be scaled such that the risk of stock-out would be less than 10%.

2) Equipment Reliability

- a) In respect of failures which are not repairable at sea, the probability that the equipment will survive the maximum operational period at the stated usage without failure is to be greater than 98.61% for motor.
- b) In respect of failures which are repairable at sea during the operational period, the probability that the equipment will survive a period of 2000 hours continuous operation without such a failure is to be greater than 99%.

3) Equipment maintainability

- a) The median active time (50 percentile) to restore or repair the equipment after failure using specified procedures and resources is not to be greater than 30 minutes.
- (b) The maximum (95 percentile) active repair time is not to be greater than 180 minutes.

14.0 Test report for following tests meeting the conditions as described in the specification shall be submitted by vendor before dispatch of motor fan unit.

- 1) Shock analysis report.
- 2) Air born noise test report.
- 3) Vibration resistance test report.
- 4) EMI/EMC test report.
- 5) Test related to delivery of required air quantity.
- 6) Environmental test report.
- 7) Painting as per spec.
- 8) Reliability and maintainability analysis report (as per 210716 of DMDE standard)

15.0 Production/ Assembly inspection: Following by BHEL's customer / representatives / nominated agency.

- a) Inspection/ testing of raw material
- b) Stage inspection.
- c) Inspection of assembly.
- d) Final testing (Routine/ Type test)AS PER IS-325.

16.0 preservation, packing and shipment
The same shall be as per annexure C.

17.0 Acceptance criteria: Apart from the tests at customers 'works, final acceptance will be subject to performance of the FV unit when type tested with motor at BHEL works.

18.0 Following information is to be submitted by the Supplier at the time of tendering. Submission of calculation of Impellor diameter & selection of the rating of blower motor, along with Pressure - Volume Curve for each Blower unit must also be submitted.

- 1. Air Quantity per Blower :
- 2. Pressure Drop :
- 3. Impeller Diameter :
- 4. Material of Fan blade :
- 5. KW input to Blower motor :
at Operating point
- 6. KW Rating of blower motor :
- 7. Frame size of blower motor :
- 8. Speed of Blower motor :
- 9. Insulation class of Blower Motor:
- 10. Make of Blower Motors :
- 12. Current rating of blower motor :
- 13. Protection class of motor :
- 14. Protection class of fan casing :

Annexure A

Shock requirement: Analysis/ test method for equipment

If the developed equipment weighs less than 200 Kgs, the same is tested for shock with stand ability in the K-200 shock testing machine. When, the developed equipment weighs more than 200 Kgs, either testing has to be carried out using suitable mechanism or sock analysis has to be carried out.

Shock Strength: The requirements of shock strength are as follows:-

(a) The equipment when installed on shock mounting should have adequate strength and be capable of trouble free operation at shock loads in the form of a single wave of a sinusoidal pulse.

(b) The strength and operational capability of the equipment of the mass up to 200 kg are to be verified only in the K-200 machine. The shock values will be specified based on foot prints, weight and CG of equipment which will need to be supplied by vendor. For equipment mass greater than 200 Kg, the supplier shall provide supporting calculations to qualify his design to the shock values. Approval of design will be accorded after the equipment meets shock requirements.

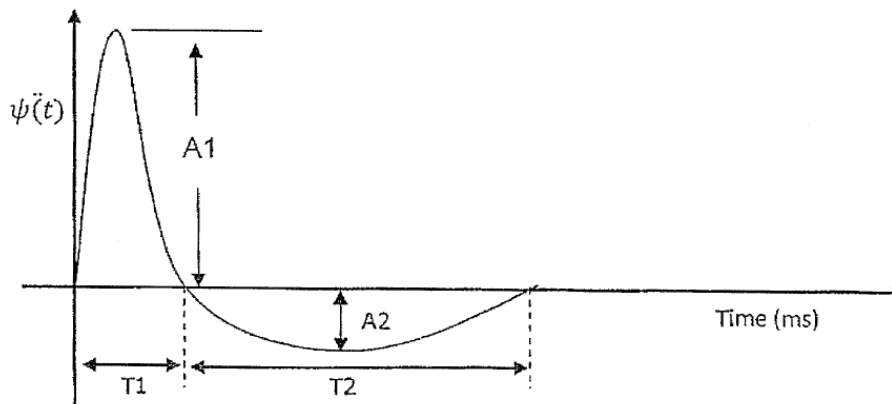
(c) The equipment should be designed so as to withstand the following shock loads of full sine wave in all three directions and should be capable of trouble free operation during and after being subjected to shock. The shock pulse need not be considered to occur simultaneously in all three directions.

Direction of impact	Longitudinal (x)				Vertical (z)				Horizontal (y)			
EQPT	A1	T1	A2	T2	A1	T1	A2	T2	A1	T1	A2	T2
RPM AIR COOLER/ VENTILATION FAN	280	2.5	90.5	7.5	130	2.5	35	9	280	2	34	16.5

A1 & A2 – Shock Amplitude (g),

T1 & T2 – Time of Half Curve (ms)

The pulse shape for two uneven sinusoid half waves is as below:



Specification of the Requirement of Shock Analysis of Equipment.

(a) Shock analysis of the equipment is to be carried out to ensure the proper functioning of the equipment under the shock loading. The shock loads likely to be experienced will be provided by the platform designer prior to commencing the shock analysis. The platform designer will need the foot print, weight and CG of the equipment in order to provide the shock loads that are likely to be experienced by the equipment.

(b) The shock analysis may be performed either by equivalent static load approach or transient dynamic analysis approach. The shock analysis is to be undertaken either in ANSYS or I-DEAS software. For equivalent static load approach, maximum shock amplitude is to be applied as inertia load and the response of the equipment is to be obtained. The stresses and deflections under the shock loading should not exceed the allowable limit. For transient dynamic analysis, the shock pulse indicated in the statement of requirement is to be applied as ground excitation. Generally, linear analysis is to be carried out if there is no non-linearity involved in the model. However, if the model has got inherent non-linearity, non-linear transient analysis has to be carried out.

(c) Apart from the above analysis, the designer/manufacturer shall carry out the normal mode dynamic analysis of the equipment to estimate the natural frequency of the equipment. The normal mode analysis is to be carried out by Block - Lanczos method.

(d) The shock mount need not be modeled in the analysis as the shock amplitude specified in the SOR is above the shock mount. Therefore, the fixed points of the equipment (the shock mount locations) is to be modeled as translational restraint which means that all three translational degrees of freedom will be fixed and all three rotational degrees of freedom will be free.

(e) Generation of solid/ surface model of the equipment and consequent development of finite element model will vary from equipment to equipment depending on the shape, size, dimensions and functioning of the equipment. Therefore, it is not possible to generalize the method of preparing the finite element model. The designer/ manufacturer shall discuss with customer before undertaking the analysis regarding above aspects. The shock analysis report is to be submitted in hard copy, the designer / manufacturer shall submit the full solid / surface model and the finite element in CD to customer.

Annexure B

EMI/EMC requirement of equipment

All electrical equipment should provide satisfactory operation in the presence of electromagnetic emissions prevalent in the vicinity of the equipment. This may be ensured by provision of suitable filtering capacitors and other filters. Inter-connecting cables must be properly terminated. Signal and control cables should have screens and should be braided. The equipment is required to undergo tests as per DND/SDG/24/EMC-1 specifications (mentioned in table below). The equipment will undergo RS06 test (The equipment under test shall not exhibit any malfunction, degradation of performance as listed in specifications when subjected to DC magnetic field of 1200 A/m) in addition to other applicable tests. In case, test facility is not available, then the testing may be carried out by means of analysis a competent organization which will be approved by the customer. The summary of the tests is given below at Table-1: -

Table-1

Requirement	Type of Test	Description	Frequency Range
CE-101	Conducted Emissions	Power Leads	25 Hz - 10 KHz
CE-102	Conducted Emissions	Power Leads	10kHz - 10 MHz
RE-101	Radiated Emissions	Magnetic Field(Cables & equipment)	25 Hz - 100 KHz
RE102	Radiated Emissions	Electric Field	10 KHz - 18 GHz
RS-06	Radiated Susceptibility	DC Magnetic Field	1200A/m

Annexure C

SPECIFICATIONS FOR PRESERVATION PACKING AND SHIPMENT

1. The supplier is to submit, for approval, a detailed specification for shipment of the products, along with drawings of transportation, fixtures, clamps, stands and packing details.

2. The interior of the equipment shall be clean and dry. All finished or machined external surfaces shall be protected against corrosion with a liberal coating of an approved, easily removable compound. The compound shall be such that it will remain on the surface at temperatures normally encountered during shipment and storage. All machine surfaces shall be protected against mechanical damage by methods approved by the Purchaser.

3. All external unfinished surfaces shall be coated with a rust preventive primer followed by one coat of alkyl paint to the approval of DMDE and meeting the requirements of maximum operating temperature of 100 deg C.

4. All the openings shall be adequately closed. Flanged openings shall be covered with a 20mm thick plywood blank flange held in place with 4 bolts and sealed with blank gasket of natural rubber or equivalent. Butt-weld openings shall be closed with wooden covers or protected with sheet metal caps and sealed with an easily removable sealing compound. The covers or caps shall be securely attached by internal or external clamps or other approved means so that they will not be dislodged by rough handling during shipment. Attachment of covers using adhesive tape alone is not acceptable.

5. A perforated container of vapor phase inhibitor shall be firmly attached to the inner surface or cover plate at either suction or discharge.

6. The equipment shall be properly protected from moisture during transportation

7. The equipment may be disassembled if it facilitates transportation. Adequate cushioning, airing, skidding, hoisting and tie-down provisions shall be included. The wooden crates shall be of sufficient thickness and quality to transport the equipment safely. All the shipping preparation shall be to the satisfaction of the Purchaser. Instructions for the assembly of the disassembled parts shall be submitted by the supplier for approval of Customer prior to the shipment or along with the shipment

8. Detailed instructions on maintenance / preservation during prolonged storage at customer's premises and de-preservation requirements prior to installation and commissioning should be sent to the consignee along with the equipment also.

9. Detailed instructions regarding preservation, packing and shipment are enumerated to subsequent paragraphs.

9.1 On completion of satisfactory tests & trials, the equipment is to be duly cleaned, painted and packed prior to despatch from the manufacturer's works or testing site.

9.2. Surface Preservation of Equipment. The surface preservation of any equipment includes three main activities or processes. These are:-

- (a) Surface preparation
- (b) Application of primer
- (c) Application of finishing coat

9.3. Surface Preparation. Careful surface preparation is a must to ensure proper adhesion of the paint scheme to the surface, which needs to be preserved. All metal surfaces must be clean and free from scale, rust or grease. Details of approved cleaning processes are given in DEF-STN 03-2. In brief the cleaning process includes the following steps:-

- (a) Removal of corrosion by mechanical (vacuum / abrasive blasting / rotary discs) or hand means (chipping / wire brushing / emery). All surfaces where the thickness is greater than 3 mm, corrosion is to be removed by blasting. In areas where the thickness is less than 3 mm or where blasting is not feasible like in corners, etc., only mechanical cleaning by chipping / wire brushing followed by emery is to be carried out. Non-ferrous metallic surfaces are to be abraded with emery.
- (b) Degreasing.
- (c) Drying.

In case of galvanised and phosphate treated steels only degreasing and drying are to be carried out. In the case of non-ferrous metals the surface has to be abraded a second time after degreasing and drying.

9.4. Application of Primer. Primer is the first coat of paint which is applied on a prepared / pre-treated surface which acts as a bond between the metal surface

and the finishing coat of the paint scheme. The primer to be applied depends on the type of finishing paint to be used in the paint scheme. The various types of primer to be used are:-

- (a) Paint RFU priming Zinc Chromate to IS 1874 – All steel surfaces of equipment to be installed in areas other than machinery spaces.
- (b) Epoxy red oxide primer to NCD 1435 – All steel surfaces of equipment to be installed in machinery spaces.
- (c) Etch primer to DEF-STAN 80-15 – All non-ferrous metals (including Aluminium) and Stainless Steel.
- (d) The primer is to be applied within 4 hours of completing the surface preparation. This is essential to prevent formation of rust / accumulation of dust over the surface prior to application of the primer. Further humidity levels at the time of primer application should not exceed 75% and temperature should not be below 15 degrees centigrade.

9.5. Application of Finishing Coat. The finishing coat of a paint scheme is the actual layer of paint which needs to be selected depending upon the type of surface and type of environment under which the surface needs to be preserved. The various types of finishing paints to be used are:-

- (a) Paint RFU Finishing Fire Retardant to JSS 3-47-05- All steel surfaces of equipment to be installed in areas of other than machinery spaces and all non-ferrous metals.
- (b) Paint Epoxy Enamel two components glossy to IS 14209 – All steel surfaces of equipment to be installed in machinery spaces.

9.6. Precautions. The following precautions are to be taken while carrying out surface preservation:-

- (a) Care must be taken to avoid damaging plated, anodic coatings, screw threads etc. during cleaning / surface preparation.
- (b) Surface should be absolutely dry before application of the paint scheme.
- (c) The primer is to be applied within 4 hours of completing the surface preparation.

- (d) Inter coat interval not to exceed 16-24 hours.
- (e) The humidity levels at the time of paint application should not exceed 75%.
- (f) The temperature should not be below 15 degrees centigrade at the time of paint application.
- (g) The paint thickness should not exceed the specified limits.
- (h) Only spray painting is to be carried out wherever possible.
- (j) Where not possible to carryout spray painting, paint should be applied with wire brush to the desired thickness.

9.7. Summary. The various types of paints to be used depending upon the type of surface and the location of the equipment is summarized in the Table-1 below:-

Table - 1
(Paint Scheme)

Sl. No	Type of Surface	Location of Equipment	Surface Preparation	Primer	Paint Finishing
1.	Steel Substrate	Machinery Spaces	>3mm- vacuum/grit blasting or wire brushing where blasting is not possible. <3mm – Wire brushing/emery, degreasing drying	Epoxy Red Oxide Primer Specification – NCD1435 No. of coats – 2 DFT – 25-30 microns (each coat)	Epoxy Enamel two component glossy specs – IS 14209. No. of coats – 2 (1 base coat + 1 finishing coat) DFT – 30-40 microns (each coat) Colour – Eau-di- Nil (Code no. 216) As per IS 5
2.	Steel substrate	Non-Machinery Spaces	Same as above	RFU priming zinc chromate specs – IS 1874. No. of coats – 2 DFT – 35-40 microns (each coat)	RFU Finishing Fire Retardant Specs – JSS 3-47-05. No. of coats – 2 DFT-35-40 microns(each coat) Machinery – Eau-di-Nil (Code no.

Sl. No	Type of Surface	Location of Equipment	Surface Preparation	Primer	Paint Finishing
					216) As per IS 5 Electrical Items – Eau-di-Nil (Code no. 216) As per IS 5 (both inside and outside)
3.	Non-ferrous (including A1 & SS)	All spaces	Wire brushing, abrading with emery Degreasing Drying Abrading with emery second time.	Etch primer specs- DEFSTAN 80-15 No. of coats - 1 DFT-10 microns (each coat) RFU priming zinc chromate as above.	RFU finishing Fire Retardant as above.